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4

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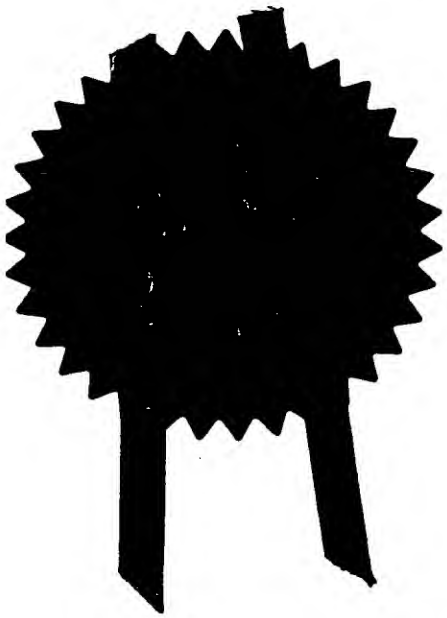

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07JUN99 E452387-1 002823
P01/7700 0.00 - 9913058.5

1. Your reference — NJH/MP5778501

2. Patent application number *(The Patent Office will fill in this part)* — **9913058.5** — 04 JUN 1999

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

TECHNOLOG LIMITED
RAVENSTOR ROAD
WIRKSWORTH
MATLOCK
DERBYSHIRE
DE4 4FY

Patents ADP number *(if you know it)* 8005304002

If the applicant is a corporate body, give the country/state of its incorporation — UK

4. Title of the invention — PILOT VALVE

5. Name of your agent *(if you have one)* — MEWBURN ELLIS

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

YORK HOUSE
23 KINGSWAY
LONDON
WC2B 6HP

Patents ADP number *(if you know it)* — 109006

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month /year)*

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11. I/We request the grant of a patent on the basis of this application.

Signature: Newbon Ellis. Date: 3 June 1999

12. Name and daytime telephone number of person to contact in the United Kingdom: ~~G. JONATHAN LINN~~ NIGEL J. HACKNEY 0161 834 0201

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DUPLICATE

PILOT VALVE

The present invention relates to a pilot valve, for example of the type which is commonly used to control a pressure reducing valve in water and gas supply systems.

Figure 1 illustrates the use of a "single chamber" pilot valve 1 to control a pressure reducing valve (PRV - shown schematically as item 2) as commonly used in a water supply system. In the context of a gas supply system such a pressure reducing valve is normally known as a "regulator" or "governor", but herein the single term "PRV" is used for simplicity as referring to both types of system. The fluid to be controlled (usually water or gas, and in this example will be taken to be water) flows along the main pipe 3 through the PRV. The outlet pressure (Po) is usually less than the inlet pressure (Pi) due to the action of the PRV.

The amount of pressure reduction is controlled by operation of the PRV under control of pilot valve 1. An auxiliary flow pipe 4 carries water from the inlet of the PRV to the control chamber 5 of the pilot valve 1 and then back to the outlet of the PRV. Prior to entering the control chamber 5, the water passes through a venturi chamber (or primary orifice) 6 or, more correctly in the context of a gas supply system, an inspirator 6 and the

water pressure (Pv) at the outlet side 7 of the chamber or inspirator controls the PRV.

The flow of water through the control chamber 5 is controlled by a gate mechanism 8 which is linked to a diaphragm 9. A spring 10 applies force to the rear of the diaphragm 9 and the amount of force supplied by the spring may be varied by an adjustment screw 11.

In a steady state situation (where Po remains constant) the water pressure in the control chamber 5 will be balanced by the force generated the spring and the gate 8 will remain in a constant position. Thus the flow through the auxiliary pipe 4 will remain constant and PV will remain constant.

If the control pressure (Po) falls, the spring 10 causes the gate 8 to open further and the flow through the auxiliary pipe increases. Accordingly, the flow through the venturi 6 also increases which results in pressure Pv decreasing, causing the PRV to open further. This results in the control pressure Po rising again and the system should then reach a steady state again at the previously set value of Po.

In order to provide an improved control system, the present applicant has already disclosed a system which

uses a "dual chamber" pilot valve in European Patent No. 574241. Figure 2 shows an example of a system utilising a "sandwich plate" dual chamber pilot 20. The pilot valve 20 performs the same general function in the control system as the pilot valve of Figure 1 but in this example the adjustment previously provided by adjustment screw 11 is effectively supplemented by an adjustment using a control pressure (Pc). As further relevant background art may be mentioned the gas supply pressure control apparatus as disclosed by the present applicant in GB-A-2252848.

The pilot valve 20 includes a second chamber 21 which is effectively divided into two portions 22 and 23 by a wall 24. The control pressure Pc effectively acts against the force of spring 10 by virtue of diaphragm 26. As with Figure 1, the spring is mechanically connected by arm 28 to a gate mechanism 8 which performs the same function as previously. The arm 28 passes through wall 24 and the aperture through which it passes is sealed by a seal 29 so that chamber 23 does not contain any water but instead is vented to the atmosphere.

If the control pressure Pc remains constant, then the system operates as explained with reference to Figure 1. However, if the control pressure Pc is reduced then the gate 27 will open further thereby reducing pressure Pv and increasing the outlet pressure Po. This is usually

referred to as a "failsafe" system since in the event that the control pressure fails i.e. falls to zero, the outlet pressure Po will be set to its maximum value.

Figure 3 illustrates an alternative but mechanically equivalent "dual chamber" pilot valve arrangement to that shown in Figure 2. The arrangement of Figure 3 is sometimes referred to as a "pancake adapted" pilot. In this arrangement, the second chamber 31 is located at the base of the pilot 30. As with the arrangement of Figure 2, the second chamber 31 is divided by a diaphragm 34 into two chambers 32 and 33 and the control pressure Pc is applied to chamber 32. The diaphragm 34 is mechanically linked via an arm 35 to the gate mechanism 8 but is not rigidly limited to the gate or spring. The arm 35 presses into control chamber 5 via an aperture which is again sealed with seal 36.

In the embodiment of Figure 3, the control pressure Pc again opposes the force produced by the spring 10 and so the control system effectively operates in an identical manner. In other words, if control pressure Pc is reduced then the outlet pressure Po is increased.

One advantage over the Figure 3 arrangement as opposed to the Figure 2 arrangement is that the additional chamber 31 can effectively be retrofitted to a single

chamber pilot valve. However one disadvantage with the dual chamber pilot valves of Figures 2 and 3 is that in both cases a seal needs to be provided in order that the control fluid is prevented from entering the second part of the additional chamber i.e. that part of the chamber to which the control pressure is not applied. The provision of such a seal can be difficult and deterioration or failure of the seal may lead to reduction in performance of the pilot valve or leakage therefrom. Furthermore, the friction caused by the seal can in turn create a frictional error in the quality of the pilot valve control.

Figure 4 shows a further "hydraulic" dual chamber pilot valve arrangement. As with the previous embodiments, a second chamber 40 is provided which is divided by a diaphragm 41 into two parts 42 and 43. The control pressure Pc is applied to part 42 of the second chamber 40 and part 43 is connected to the spring chamber which is vented to the atmosphere. As before, the diaphragm 41 is mechanically connected to the gate 8, in this case via the spring 10.

However, unlike the embodiments of Figure 2 and Figure 3 in the embodiment of Figure 4 the control pressure Pc acts in the same direction as the force of the spring 10, rather than against it. This means that the

control system works in the opposite way to that of Figures 2 and 3 i.e. if the control pressure Pc is reduced then the gate 8 closes further, the venturi pressure Pv increases causing the PRV to close further and the outlet pressure to drop. This arrangement is not considered to be "failsafe" since a loss of control pressure Pc would result in the lowest possible outlet pressure Po. This is sometimes referred to as a "direct acting" control system rather than the "reverse acting" control systems of Figures 2 and 3.

The present invention aims to provide a pilot valve of the "reverse acting" type but which eliminates the need for a seal.

In a first aspect, the present invention provides a pilot valve which includes

biassing means to control a gate for controlling fluid flow through a control chamber;

a second chamber sealed by a second chamber diaphragm into which control pressure is appliable for also controlling the operation of the gate, whereby in use an increase in control pressure acts to reduce fluid flow through the gate;

wherein the side of the diaphragm against which the control pressure is not applied is in fluid communication with the control chamber.

In this way, a "reverse acting" dual chamber pilot valve is provided in which the need for any seal in association with the second chamber is avoided.

The fluid which in use flows through the control chamber may or may not be the same fluid or type of fluid as the fluid which in use is used to apply the control pressure. The fluids in question may, for example, be water or gas. In other words, in one example both fluids in question may be water; in another example both fluids may be gas; in a third example one fluid may be water and the other gas.

Preferably, the biassing means is a spring means or spring such as a helical spring. Preferably the biassing means is biassed to open the gate and may be rigidly connected to the gate by a suitable mechanical linkage. Preferably the diaphragm is also rigidly connected to the gate and/or spring via the same or a second suitable mechanical linkage.

Preferably, the control chamber is at least partly bounded by a control chamber diaphragm in addition to the second chamber diaphragm. Preferably biassing means is located on the opposite side of the control chamber diaphragm to the control chamber. As will be explained in detail later in the specification, by appropriately

selecting the areas of the second chamber diaphragm and the control chamber diaphragm, the effect of the control pressure on the fluid flow through the control chamber (and therefore in use, on the outlet pressure) can be selected.

In a preferred embodiment, the ratio of the area of the control chamber diaphragm to the second chamber diaphragm is 2:1 or less. For example, if the control chamber diaphragm is twice the area of the second chamber diaphragm then a particular drop in control pressure will result in an identical increase in outlet pressure. In a different example, if the area of the second chamber diaphragm is three-quarters that of the control chamber diaphragm then an increase in control pressure of a given amount would cause the outlet pressure to decrease by three times that amount. The particular case in which the second chamber diaphragm area is half that of the control chamber diaphragm effectively replicates the function of the "sandwich" and "pancake" arrangements described earlier with reference to Figures 2 and 3.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a single chamber

pilot valve control arrangement;

Figure 2 is a schematic diagram of a "sandwich" dual chamber pilot valve arrangement;

Figure 3 is a schematic diagram of a "pancake" dual chamber pilot valve arrangement;

Figure 4 is a schematic diagram of a "hydraulic" dual chamber pilot valve arrangement; and

Figure 5 is a schematic diagram of a pilot valve according to an embodiment of the present invention.

Figure 5 shows a pilot valve 50 which includes a control chamber 51 and a second chamber 52. A control pressure Pc is applied to chamber 52 in use and chamber 52 is divided from control chamber 51 by a second chamber diaphragm 53.

The second chamber diaphragm 53 is rigidly connected via linkage 54 to a gate mechanism 55. The gate mechanism 55 is also connected via a further rigid linkage 56 to a spring 57. The spring 57 is isolated from the control chamber 51 by the control chamber diaphragm 58. The action of the force of the spring 57 on the diaphragm 58 may be adjusted by adjustment screw 59.

As can be seen from Figure 5, the control fluid (which may be gas or water) present in the control chamber 51 acts against the opposite side of the second chamber

diaphragm 53 to the control pressure Pc. In operation, if, for example, control pressure Pc is reduced then the gate 55 will open further causing the fluid flow through the control chamber to increase. When used in a PRV control circuit, as explained previously, this will cause the outlet pressure to increase.

As indicated in Figure 5, the area of the control chamber diaphragm 58 is designated A and the area of the second chamber diaphragm 53 is designated as A'. The balance of forces operating in the pilot valve is as follows:

$$SF = APo - A'Po + A'Pc$$

$$= (A-A')Po + A'Pc$$

In a first example, if $A' = \frac{1}{2}A$

$$SF = A'(Po + Pc)$$

If a "multiplication" effect is required then the relative cross-section areas can be set to a different value. In a second example, if $A' = 3/4\ A$, the equation will be

$$SF = \frac{1}{4}\ A\ (Po + 3PC)$$

Therefore an increase of Pc of a given amount would

cause Po to decrease by three times the amount and vice versa.

The above embodiment is given by way of example only and variations will be apparent to those skilled in the art.

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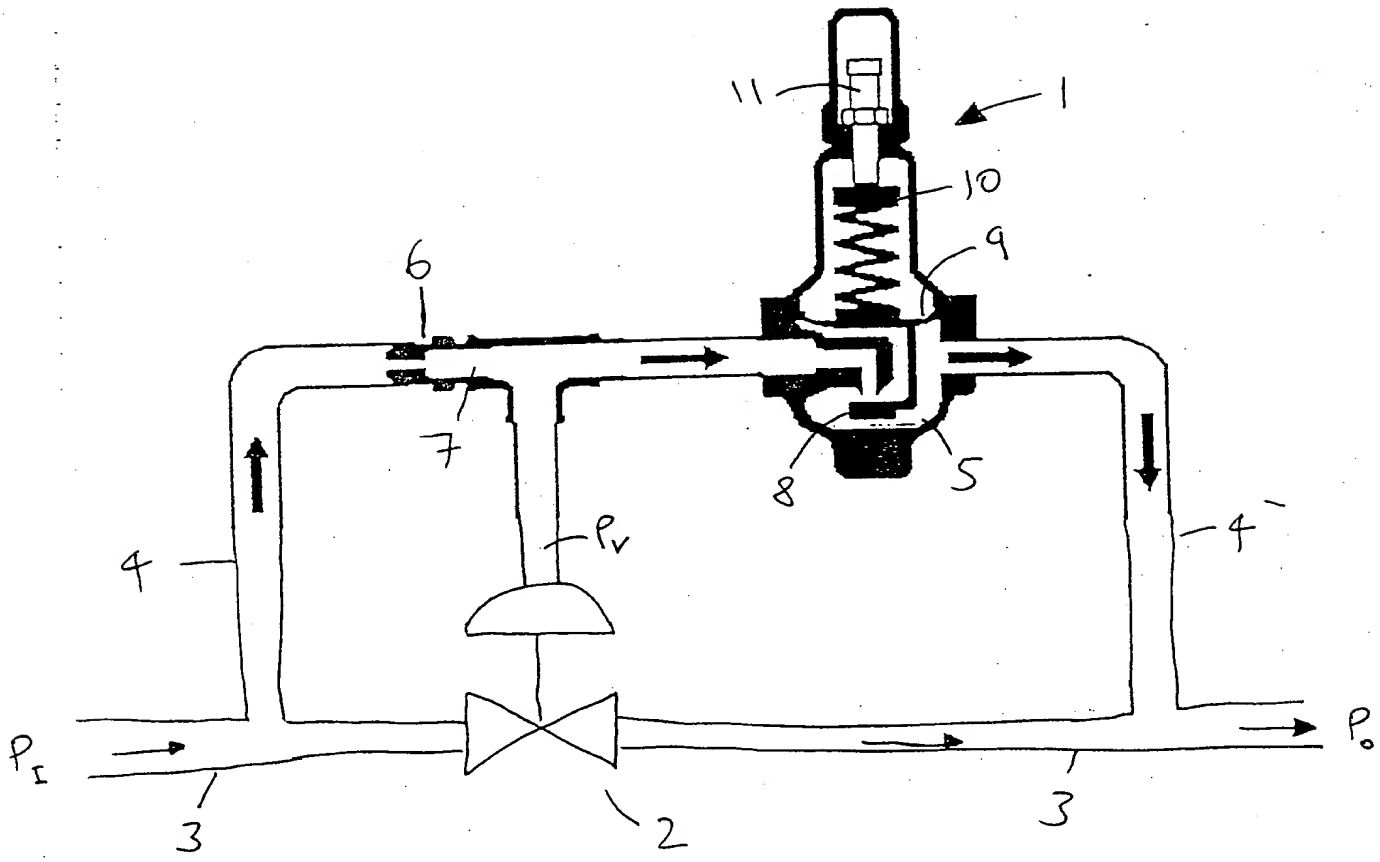

FIG 1

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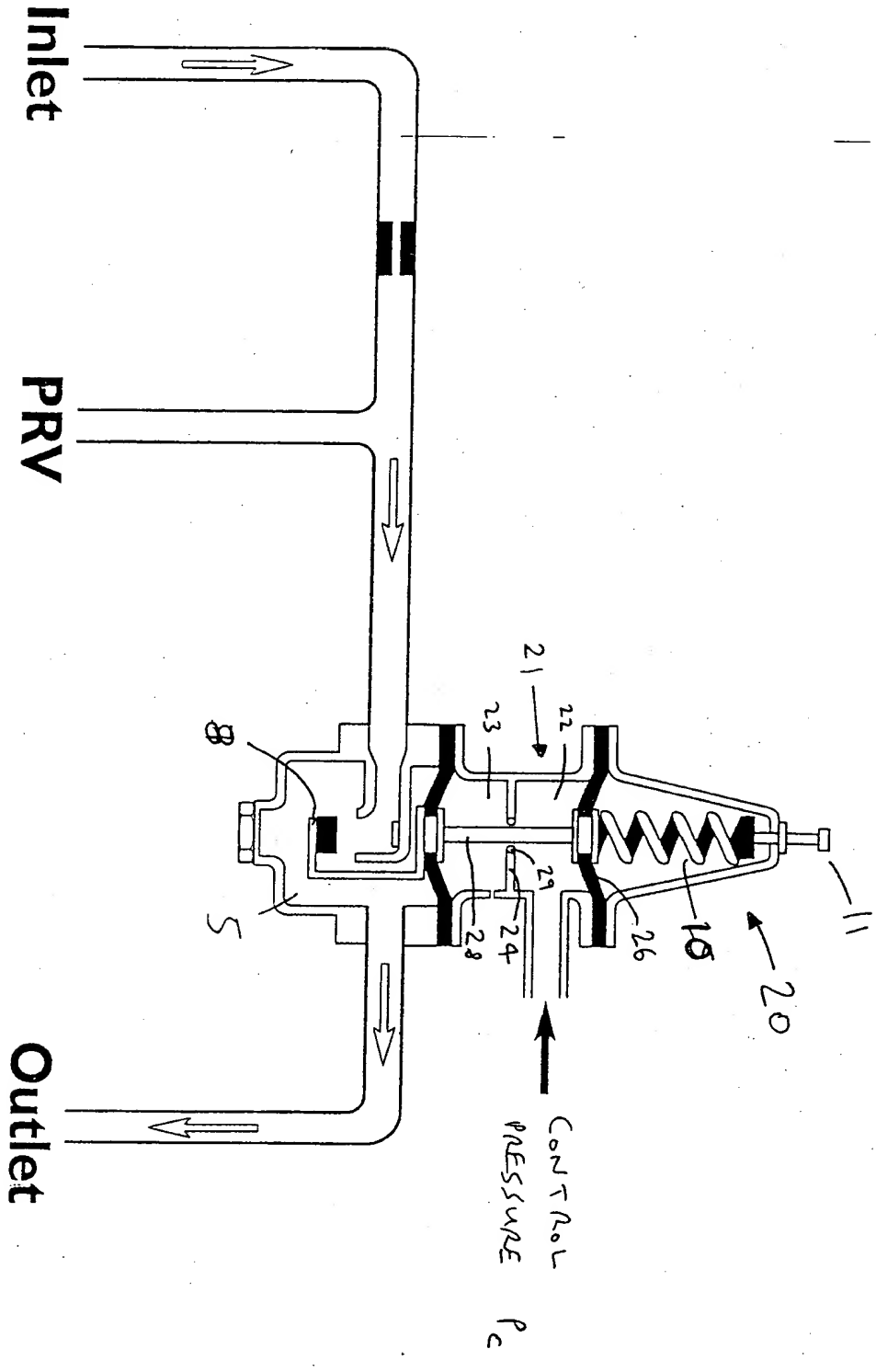
Inlet
PRV
Outlet
8
5
21
22
23
29
24
28
26
10
11
20
CONTROL PRESSURE P_c

FIG 2

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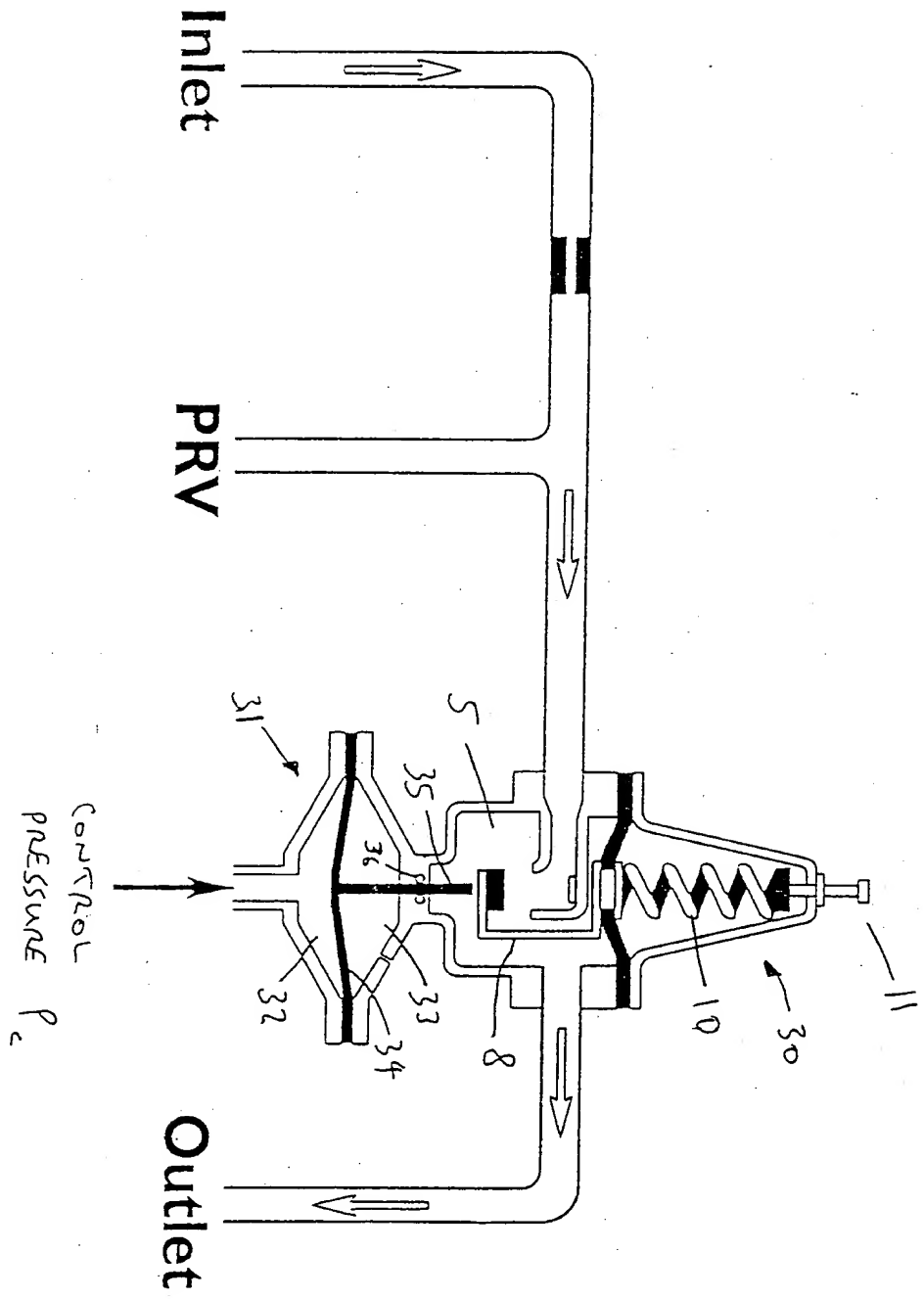
Inlet
PRV
Outlet
Control
pressure P_c
31
5
35
36
32
33
34
8
10
30
11

FIG 3

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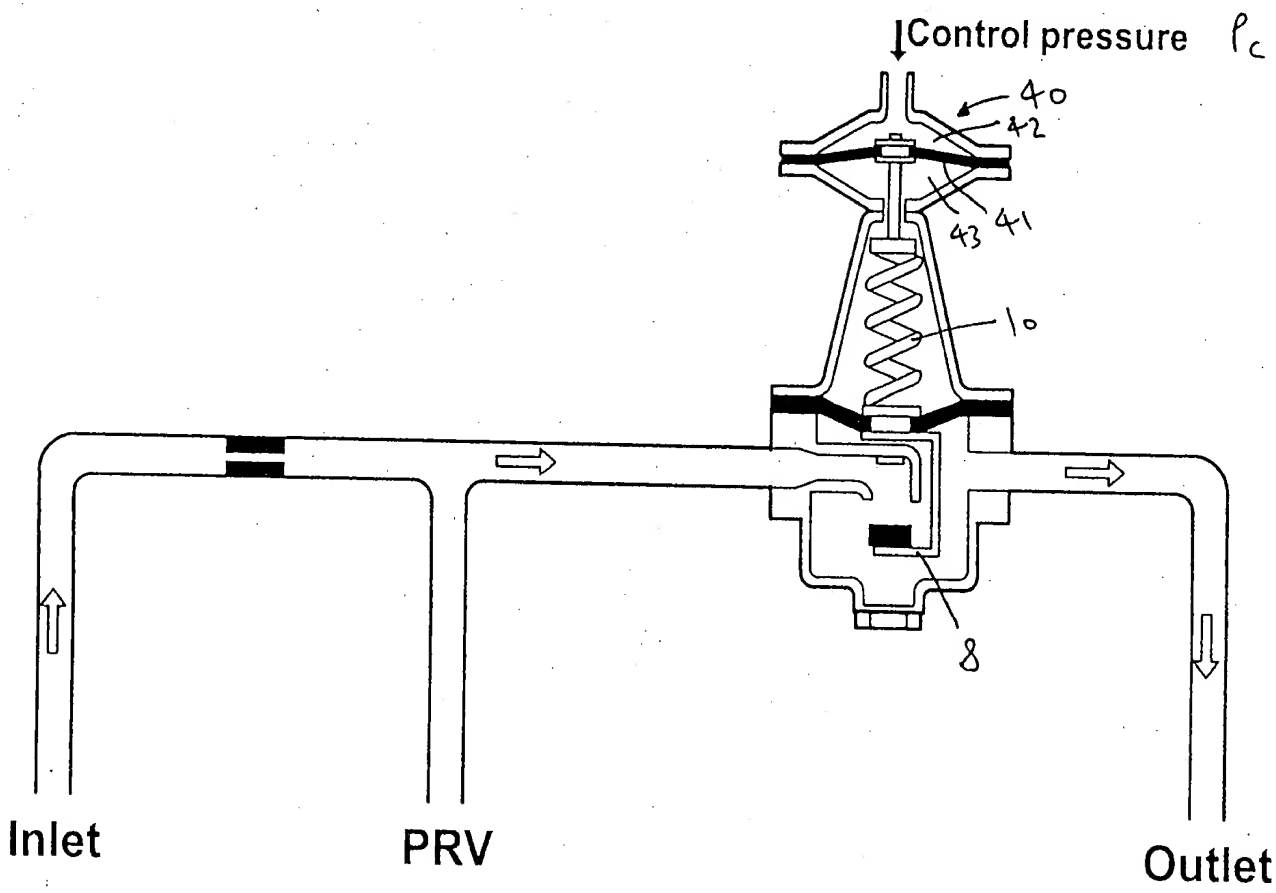

FIG 4

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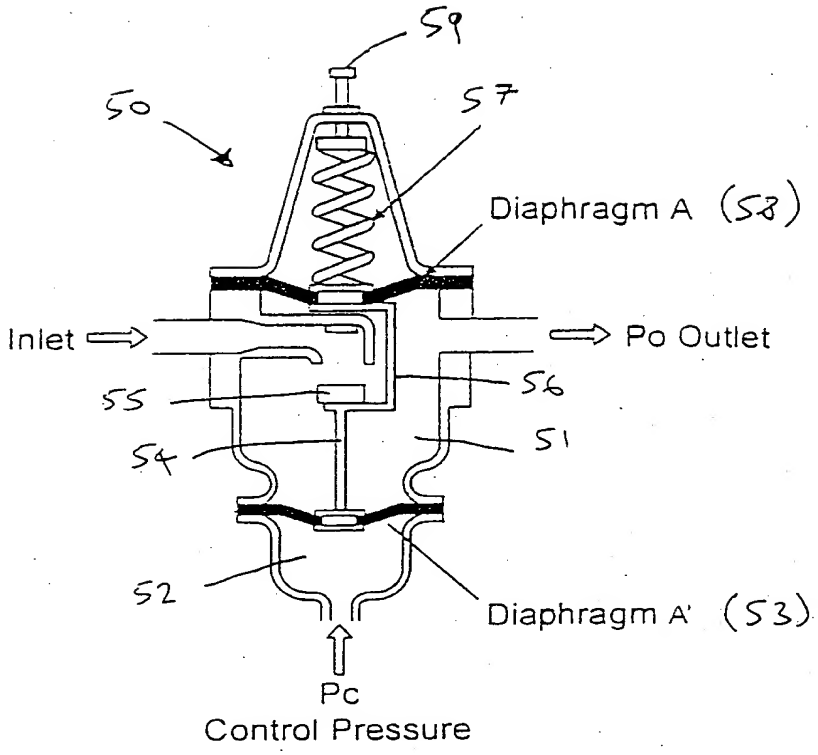
59
50
57
Diaphragm A (58)
Inlet
Po Outlet
55
56
54
51
52
Diaphragm A' (53)
Pc
Control Pressure

FIG 5

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